

objectives of therapy are to provide the maximum potential for neurologic recovery and to prevent recurrent injury. Steroid therapy has not been studied specifically in these patients. Based on the results of treating other patients with myelopathy with methylprednisolone, however, we strongly recommend high-dose intravenous methylprednisolone sodium succinate therapy for patients with spinal cord injury regardless of the cause or radiographic findings. Methylprednisolone should be administered intravenously as a bolus of 30 mg per kg of body weight followed by an infusion at 5.4 mg per kg per hour for 23 hours.

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Management of Growth Hormone-Secreting Pituitary Adenomas—Early Diagnosis Leads to Successful Treatment

ACROMEGALY IS THE LEAST SUBTLE of the hypersecretion syndromes from pituitary adenomas, although it is frequently missed in the early stages of the disease. Not only is the disease disfiguring, it is also disabling and has substantial associated morbidity and mortality. Consequently, the successful management of patients with this disease is dependent on the prompt and proper integration of surgical and medical therapies.

The clinical features of growth hormone (GH) hypersecretion are well known to most clinicians and include coarsening of facial features, enlargement of the hands and feet, and increased water retention within soft tissues. The diagnosis of acromegaly is made by showing elevated basal serum GH and somatomedin C levels along with radiographic confirmation of the presence of a tumor in the sella turcica on magnetic resonance imaging. Occasionally hormonal values will be normal in patients with symptoms suggestive of acromegaly. In these cases, the diagnosis can be confirmed by demonstrating nonsuppression of the serum GH levels during an oral glucose tolerance test. A normal response is a fall in the GH level to below 2 ng per ml after 75 to 100 grams of oral glucose. Similar criteria are used to assess the adequacy of treatment after surgical intervention.

Surgical resection remains the primary mode of treatment of patients with GH-secreting pituitary adenomas. In most cases, a transsphenoidal operation can achieve complete extirpation of the tumor with preservation of normal pituitary function. Only rarely, if the tumor is extraordinarily large, will a craniotomy be required. Resection is contraindicated in severely debilitated patients or when pituitary hyperplasia from a concomitant hypothalamic lesion is suspected. Basal GH levels are expected to return to normal in 60% to 90% of patients after surgical treatment, most frequently when the tumor is a microadenoma (less than 1 cm in diameter) and when the preoperative hormone level is less than 40 ng per

ml. In this group, acromegalic symptoms will be relieved and normal pituitary function preserved in greater than 90% of patients.

The medical management of acromegaly is based on the physiologic regulation of GH secretion. An analogue of somatostatin, the natural inhibitor of GH release, has recently been developed that has been shown to cause short- and long-term reduction of GH levels when given in 100- μ g subcutaneous injections two or three times a day. In about 50% of people with acromegaly, GH and somatomedin C levels return to normal following octreotide acetate treatment; the associated symptoms and signs are alleviated in 80% of patients. The principal side effect of the medication has been gastrointestinal irritability, and its use has been associated with an increased incidence of gallstones. Although tumor size does decrease in response to octreotide therapy, the effect is not as rapid nor as pronounced as the response of prolactin-secreting macroadenomas to the administration of bromocriptine. The present indications for octreotide therapy include tumors that are not cured by surgical therapy and patients who are not considered surgical candidates. Octreotide may also play a role as a preoperative adjunct to aid the surgical removal of tumor in the future.

Radiation therapy can be considered in patients who do not respond to surgical and medical therapy. Conventional techniques using a total dose of 45 to 50 Gy have been recommended. A hormonal response, however, may take as long as several years and frequently is associated with panhypopituitarism. Stereotactic radiosurgery using the linear accelerator or gamma knife has recently been used to precisely irradiate selected intracranial neoplasms. Several patients with pituitary tumors have been treated, but long-term results are not available at the present time.

The sequelae of acromegaly, including disfigurement, hypertension, cardiomyopathy, and death, underscore the need for the urgent treatment of these patients. In many cases the physical signs and symptoms are reversible. Improved surgical techniques and new medical strategies may allow more effective management in the future.

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Interventional Neuroradiology—A New Approach to Difficult Vascular Lesions of the Brain

INTERVENTIONAL NEURORADIOLOGY has assumed an important role in the treatment of intracranial cerebrovascular lesions, particularly in high-risk patients in whom a poor surgical result would be expected. Such lesions as intracranial aneurysms, vascular malformations, vasospasm following subarachnoid hemorrhage, and thromboembolic stroke are amenable to treatment by the endovascular approach. Either as the sole therapy or in conjunction with a surgical procedure, interventional radiology is proving to be a valu-

able treatment alternative for difficult vascular lesions of the central nervous system.

Highly specific treatment can be administered, including but not limited to the instillation of pharmacologic agents, the injection of particulate embolic substances or glue embolization, the release of detachable microcoils, the inflation of detachable and nondetachable balloons, or a combination of these agents. This less-invasive therapy often allows patients to be discharged from hospital within three days. Some patients require several sessions of therapy, which may be spread out over a period of weeks. Other patients need only a single session. Patients undergoing endovascular therapy are usually selected because they are poor surgical risks or are those in whom conventional neurosurgical techniques are likely to be unsuccessful. As endovascular techniques improve with evolving technology and experience, endovascular therapy will likely become the prime mode of therapy for certain indications.

Intracranial aneurysms can be treated by endovascular occlusion of the aneurysm itself or its feeding artery. This offers the benefits of continuous monitoring of the patient's neurologic status during the procedure, the avoidance of general anesthesia and brain retraction, and immediate high-quality angiography for verification of the procedure's success. For these reasons, several centers have been actively pursuing coil embolization of aneurysms. Small microcoils are pushed through a microcatheter into the aneurysm itself until the aneurysm sac is virtually filled. This may require the placement of multiple coils of varying sizes and configurations. The coils are detached either mechanically or electrolytically. Pitfalls include incomplete thrombosis of the aneurysm, difficulties in access, unintentional aneurysmal rupture or vascular damage, thrombosis of normal adjacent vessels, and ischemic complications. Long-term follow-up for these patients is required. Further research is ongoing, but it is clear that this technique holds great promise.

Intracranial arteriovenous malformations are well suited to endovascular techniques. Surgical access may be difficult or impossible, and some lesions are too large for effective focused radiotherapy. To select patients suitable for treatment, we analyze angiographic risk factors predisposing to bleeding and "steal" symptoms. Endovascular embolization is especially useful as an adjunct to conventional neurosurgical and radiosurgical procedures. Advantages include continuous neurologic monitoring of awake patients, the ability to test vascular territories using intra-arterial administration of amobarbital, and the staged obliteration of the larger malformations to minimize altered hemodynamics. Microcatheters are maneuvered into the feeding arterial pedicles of the arteriovenous malformations, and a rapidly polymerizing cyanoacrylate liquid adhesive is administered to thrombose the arteriovenous malformations. Many pedicles can be devascularized in one session, but the larger malformations require several sessions. A few intracerebral arteriovenous malformations may be cured by this technique, and in most lesions the size of the lesion and blood flow are substantially reduced. Limitations of the procedure are related to vascular access problems, the location of the feeding vessels in critical contiguous areas, and the risks of induced hemorrhage or infarction. In more than 100 such procedures, results have been encouraging, with long-term follow-up continuing.

Symptomatic vasospasm after subarachnoid hemorrhage is still a challenge in neurosurgical management. Endovascu-

lar treatments include mechanical dilatation of the vasospastic areas using balloon angioplasty. This technique can be used to reach lesions in large arteries of the circle of Willis. Associated problems include possible aneurysmal rupture if the aneurysm has not already been treated, worsening ischemic changes leading to infarction, and difficulty of access to the narrowest distal arterial branches and perforators, which may be responsible for the ischemic symptoms. The endovascular treatment of vasospasm using pharmacologic agents such as intra-arterial papaverine hydrochloride and other agents may also prove useful. The long-term effects of intracranial angioplasty and pharmacologic treatment of vasospasm are not known and remain a worthwhile avenue of inquiry.

Perhaps the most exciting and rapidly developing indication for endovascular techniques in the cerebral circulation is that of thrombolytic therapy for acute occlusive stroke. While trials of intravenous thrombolytic therapy are taking place at major medical centers, the ability to selectively administer thrombolytic and neuroprotective agents may render our present "treatment" of acute stroke obsolete. Direct intra-arterial administration of urokinase, a thrombolytic agent, into the acutely occluded basilar and carotid vessels has had some success. The results of our limited experience using intra-arterial tissue plasminogen activator to lyse thromboembolic material in the acute stages of stroke appear promising. Far more work needs to be done, but the benefits could be enormous.

Interventional endovascular therapy for cerebrovascular disease has already had important effects. Certain limitations exist, and open microsurgical techniques and stereotactic radiosurgery remain mainstays of treatment in the foreseeable future. Nonetheless, with further technical advances and clinical experience, endovascular therapy for disorders in the central nervous system can be expected to flourish.

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Preventive Aspects of Helmet Safety

HELMET USE HAS BEEN SHOWN to be effective in reducing the extent of injury in both motorcycle and bicycle accidents. Motorcycle helmet use reduces the incidence of severe head injuries by 50%, regardless of the speed limit. After repeal of Kansas's helmet law, the incidence of head injuries increased by 70%, with helmetless motorcyclists at an 81% greater risk of serious injury. In 1990 bicycle helmet use became compulsory in Victoria, British Columbia. It resulted in a marked reduction in the number of hospital admissions of injured cyclists and in the proportion of head injuries compared with the previous year.

In 1974 Congress repealed the US Secretary of Transportation's right to influence states to enforce helmet laws. Ar-